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(54) **Tape duplicating apparatus.**

(57) In an apparatus for producing duplicate tapes by transmitting signals (V, A_1, A_2) reproduced by a master VTR (1) to a plurality of duplicating VTRs (10) for simultaneous recording on respective tapes in the latter, control signals from a bidirectional remote control unit (20) are modulated with a first modulating frequency and are transmitted over a bidirectional control signal line (BDL) to the duplicating VTRs (10). If a response is required from one of the duplicating VTRs (10), response signals from such duplicating VTR (10) are modulated with a second modulating frequency different from the first modulating frequency, and during a pause in signal transmission from the remote control unit (20), the modulated response signals are transmitted to the remote control unit (20) over the bidirectional control signal line (BDL). A test signal is transmitted to the duplicating VTRs (10) in place of the signal reproduced by the master VTR (1), and defects in the recording operation of the duplicating VTRs (10) are detected from playback of the test signal recorded by the respective duplicating VTRs (10).

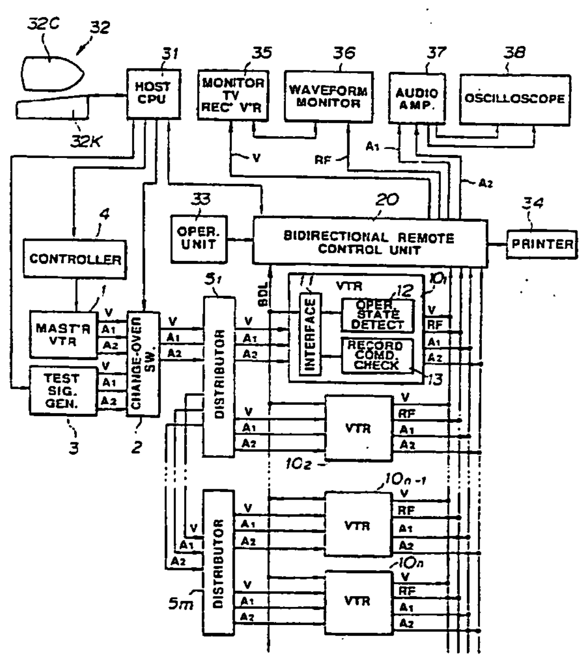

FIG.1

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This invention relates to tape duplicating apparatus.

Apparatus presently exists in which video and audio signals being reproduced by one or more master video tape recorders (VTRs) or video disc players are transmitted to a substantial plurality of duplicating or slave VTRs for simultaneous recording, that is, copying or dubbing, by all of the duplicating or slave VTRs on respective tapes. In this apparatus for preparing duplicate tapes, operators are needed to supervise the operations of the duplicating or slave VTRs so as to remove from the apparatus any of such duplicating or slave VTRs that appear to be malfunctioning. Alternatively, operators are needed to reproduce or playback each duplicate tape and to remove from the goods to be marketed any of such tapes containing defects in recording. If duplicated tapes containing recording defects were permitted to enter the marketplace, commercial trust in the goods would be substantially deteriorated.

Furthermore, if the number of duplicating or slave VTRs employed in the above described apparatus for preparing duplicate tapes is substantially increased, the control system for the duplicating VTRs becomes undesirably complex.

This invention provides tape duplicating apparatus comprising:

at least one source of video and audio signals;

a plurality of tape recording units;

means for connecting said tape recording units with said source so that said tape recording units can simultaneously record said video and audio signals.

a bidirectional control signal line connected to all of said tape recording units;

remote control means including means for generating command signals for said tape recording units, and first modulating means for modulating said command signals with a first modulating frequency to provide modulated command signals supplied through said bidirectional control signal line to said tape recording units;

each of said tape recording units including means for demodulating the modulated command signals, means for generating response signals in response to at least a subset of the demodulated command signals, and second modulating means for modulating said response signals with a second modulating frequency different from said first modulating frequency to provide modulated response signals supplied through said bidirectional control signal line to said remote control means.

Viewed from a second aspect this invention provides a tape duplicating apparatus comprising:

at least one source of video and audio signals;

a plurality of tape duplicating units having recording and playback modes;

means for connecting said tape duplicating units with said source in said recording mode of the tape duplicating units so that said tape duplicating units simultaneously record said video and audio signals;

test signal generating means for providing a test signal;

means for applying said test signal to said tape duplicating units in said recording mode of the tape duplicating units for recording said test signal;

means for changing said tape duplicating units to said playback mode so as to reproduce the recorded test signal; and

detecting means associated with each of said tape duplicating units for indicating a defect in the recording operation of the respective tape duplicating unit in response to the test signal reproduced therefrom.

Viewed from a third aspect this invention provides a method of duplicating a master tape recorded with video and audio signals, the method comprising the steps of;

playing back said master tape so as to obtain said video and audio signals reproduced therefrom;

applying the reproduced video and audio signals to a plurality of duplicating video tape recorders for simultaneous recording on respective tapes;

selectively applying a test signal to said duplicating video tape recorders for recording on the respective tapes;

reproducing the recorded test signal; and

detecting from the reproduced test signal whether there is a defect in the recording operation of the respective duplicating video tape recorder.

In at least a preferred embodiment of this invention, a tape duplicating apparatus having at least one source of video and audio signals and a plurality of tape recording units connected with such source so that the tape recording units can simultaneously record the video and audio signals on respective tapes, is further provided with a bidirectional control signal line connected with all of the tape recording units, remote control means for generating command signals which are modulated with a first modulating frequency and then supplied through the bidirectional control signal line to the tape recording units, and means in each of the tape recording units for generating response signals in response to the received command signals, with such response signals being modulated with a second modulating frequency different from the first modulating frequency to provide modulated response signals also supplied through the bidirectional control signal line to the remote control means preferably in intervals between the transmission of the modulated command signals through such line. It will be appreciated that, by reason of the frequency and time-division multiplexing of the modulated command and response signals, as supplied through the bidirectional control signal line, a large plurality, for example, up to 1000, of duplicating VTRs can be controlled

by way of a single bidirectional control signal line.

At least preferred embodiments of this invention also provide a tape duplicating apparatus, as aforesaid, in which the recording operations of the tape recording units or VTRs are automatically monitored, and any defective tape recording unit or VTR is rendered inoperative so as to reduce the need for operators to inspect all of the recorded duplicate tapes one-by-one.

In accordance with another preferred embodiment of this invention, in a tape duplicating apparatus having at least one source of video and audio signals transmitted to a plurality of tape duplicating units or VTRs having recording and playback modes and in which the video and audio signals from the source thereof are simultaneously recorded on respective tapes; a test signal is provided by a respective generating means and is applied to the tape duplicating units in the recording mode of the latter for recording the test signal on the respective tapes, whereupon the tape duplicating units are changed-over to the playback mode so as to reproduce the recorded test signal, and defects in the recording operations of the tape duplicating units are detected from the respective reproduced test signals.

In at least a preferred embodiment of this invention there are provided control means responsive to the detection of a defect in the recording operation of a respective tape recording unit for rendering inoperative such tape recording unit, and means for erasing the recorded test signal from a tape when no defect in the recording operation of the respective tape recording unit has been detected.

At least preferred embodiments of this invention provide a tape duplicating apparatus which avoids the above mentioned problems associated with the prior art, in which video and audio signals are transmitted from at least one source thereof to a plurality of tape recording units or VTRs so as to be simultaneously recorded on respective tapes in such units, and in which such tape recording units are controlled in a manner to substantially simplify the connections thereto.

The invention will now be described by way of example with reference to the accompanying drawings, throughout which like parts are referred to by like references, and in which:

Figure 1 is a block diagram showing a tape duplicating apparatus according to one embodiment of the present invention;

Figure 2 is a block diagram showing, in greater detail, a bidirectional remote control unit and one of the duplicating VTRs included in the apparatus of Figure 1;

Figure 3 is a block diagram further showing circuit arrangements included in the bidirectional remote control unit and the duplicating VTRs of the apparatus shown in Figure 1;

Figure 4 is a diagrammatic view illustrating a communication format that is used in the apparatus of Figure 1;

Figure 5 is a timing chart illustrating the time relationship between command signals transmitted from the remote control unit in the apparatus of Figure 1 and responses to such command signals transmitted to the remote control unit from respective duplicating VTRs;

Figure 6 is a diagrammatic view illustrating a procedure employed in the apparatus of Figure 1 for determining if the recording operations of the duplicating VTRs are defective;

Figure 7 is a block diagram of a tape duplicating apparatus according to another embodiment of the present invention which is of a larger scale than that shown on Figure 1, and in which the control system of the tape duplicating apparatus is particularly illustrated;

Figure 8 is a block diagram particularly showing a video and audio signal transmitting system included in the tape duplicating apparatus of Figure 7;

Figure 9 is a front elevational view of a practical realization of the tape duplicating apparatus, for example, according to the embodiment shown in Figure 1; and

Figure 10 is an exploded perspective view showing a particular embodiment of a duplicating VTR and a respective cassette changer employed in the tape duplicating apparatus of Figure 9.

Referring now to Figure 1, an apparatus for preparing duplicate tapes comprises a so-called- D-2 format digital VTR, for example, which is used as a master VTR 1 operating as a video and audio signal source. Video signals V and two-channel audio signals A_1, A_2, associated with stereo left and right channels, are transmitted from the master VTR 1 to a plurality of tape recording units, such as, n VTRs 10_1, 10_2, ... 10_{n-1}, 10_n, for simultaneously preparing n duplicate tapes. More specifically, the signals from the master VTR 1 are transmitted through a changeover switch 2 to distributors 5_1 to 5_m and thence distributed to the n VTRs 10_1 to 10_n. If the master VTR 1 is a digital VTR, D/A converters (not shown in Figure 1) are provided in the distributors 51 to 5_m. The changeover switch 2 selects a video signal V and 2-channel audio signals A_1, A_2, from the master VTR 1 or a test video signal V and test audio signals A_1, A_2 from a test signal generator 3 for transmission to the n VTRs 10_1 to 10_n.

A remote control unit 20 is connected to the n VTRS or recording units 10_1 to 10_n for transmitting and receiving control signals to and from the units over a bidirectional control signal line BDL, such as a so-called BNC coaxial cable. The n VTRs 10_1 to 10_n are connected to the bidirectional control signal line BDL by so-called T-connectors (not shown). The remote control unit 20 is connected to a host CPU 31 over a bus line conforming to the so-called RS-232C serial inter-

face standard.

An input/output terminal unit 32 having a CRT monitor 32C and a key input unit or keyboard 32K is connected to the host CPU 31. An operating unit 33 is also connected to the remote control unit 20 by a connection conforming to the RS-232C serial interface standard. The operating unit 33 is provided with operating keys for remote operation of the recording units or VTRs 10_1 to 10_n. The remote control unit 20 is further connected to a printer 34 for obtaining a printed record of data. The host CPU 31 controls the operation of the master VTR 1 through a controller 4 and also controls the change-over operations of the switch 2 and the operation of the test signal generator 3.

When any one of the VTRs 10_1 to 10_n is in its reproducing or playback mode, the respective reproduced video signals V, RF signals RF and 2-channel audio signals A_1 and A_2, associated with left and right stereo channels, are transmitted from that VTR over a common video signal line, an RF signal line and two-channel audio signal lines through the remote control unit 20 to a monitor TV receiver 35, a waveform monitor 36 and a two-channel audio amplifier 37. Two channel audio signals are further transmitted from the audio amplifier 37 to an oscilloscope 38. The monitor TV receiver 35, waveform monitor 36 and the two-channel audio amplifier 37 are used for monitoring or observing the waveform of the video signal V, RF signal RF and the two-channel audio signals A_1 and A_2 from a selected one of the VTRs 10_1 to 10_n designated by the remote control unit 20. The monitor TV receiver 35 is also adapted for displaying, by so-called superimposition, data transmitted or received over the signal line BDL.

In one or more of the VTRs, such as in VTR 10_1, there is provided in interfacing circuit 11 connected to the bidirectional control signal line BDL. To this interfacing circuit 11, there are connected at least an operating state detecting circuit 12 for detecting the operating state, such as, a recording mode or a playback mode, of the associated VTR 10_1, and for outputting information identifying the detected operating state, and a recording condition checking circuit 13 for determining whether recording on the video tape is proceeding normally and for outputting information concerning the check results.

The remote control unit 20 transmits control signals for a desired operating mode, such as, recording mode control signals, to selected ones of the VTRs 10_1 to 10_n to effect a simultaneous changeover of the selected VTRs to the recording mode. More specifically, the $\underline{n}$ VTRs 10_1 to 10_n are classified into groups each consisting of a desired number of the VTRs and the operating modes of all of the VTRs of a selected one of the groups are controlled simultaneously. The remote control unit 20 further designates a selected one of the VTRs in a selected group, such as, the VTR 10_1, to cause detection signals to be transmitted from the operating state detecting circuit 12 of the designated VTR 10_1 through the bidirectional control signal line BDL for determining therefrom if the designated VTR 10_1 is in a recording mode. Up to 1000 VTRs may be connected to the remote control unit 20 and may be classified into up to 100 groups, with the maximum number of VTRs in a group being 1000. However, so-called collision detection is not implemented because it is desired to provide the simplest possible communication hardware in each of the up to 1000 VTRs.

Since data simultaneously output on the single bidirectional control signal line BDL by more than one VTR cannot be handled as an error, the remote control unit 20 is used to command communication with the VTRs 10_1 - 10_n one at a time. In other words, the remote control unit 20 designates an identification number (ID number) of the VTR to which a command is to be communicated. The ID number designated by the remote control unit 20 may be that for a single VTR or for a group of the VTRs. Furthermore, the modulation frequency of the command or control signals transmitted from the remote control unit 20 through the line BDL is selected to be different from that of any response signals transmitted through the line BDL from the VTRs 10_1 to 10_n. Thus, frequency multiplexing, by using different transmission and reception frequencies, is employed in conjunction with time division multiplexing, which is achieved by the VTRs transmitting signals only in response to signals received by the respective VTRs from the remote control unit 20, and which avoids signal overlapping on the signal line BDL. In such time division multiplexing, the remote control unit 20 first transmits control signals requesting a response from a selected one of the VTRs and subsequently halts transmission of control signals for a predetermined time to wait for a response from the selected VTR which, on reception of the request for response from the remote control unit 20, transmits a response signal during the above-mentioned predetermined time.

The checking circuit 13 for determining the recording results achieved by the respective one of the VTRs 10_1 to 10_n is responsive to signals obtained by reproduction of the recorded tape to check if recording has been proceeding properly. If recording has not been proceeding properly, the respective VTR is turned off so that its operating stage detecting circuit 12 will indicate that the respective VTR is in its OFF mode. The information concerning the recorded results is output from the respective VTR and transmitted to the remote control unit 20 in response to a request signal from the remote control unit 20. In this case, the remote control unit 20 polls the $\underline{n}$ VTRs 10_1 to 10_n to request information concerning the test results, and such test information is displayed on the CRT monitor 32C or monitor TV receiver 35, and, if necessary, printed by the printer 34.

Referring now to Figure 2 which schematically shows in greater detail the arrangements of the bidirectional remote control unit 20 and of a selected one of the recording units or VTRs indicated at 10, the remote control unit 20 comprises a command processing circuit 21 for command transmission and reception to and from the host CPU 31, a command execution circuit 22 connected to the command processing circuit 21 and a VTR control circuit 23 connected to the command executing circuit 22 for controlling the VTR 10 in response to the executed command. A display processing circuit 24 is connected to the command executing circuit 22 for providing display signals corresponding to the executed command and which are transmitted to the operating unit 33 and printer 34. An output command signal, produced on actuation of a respective operating key (not shown) of the operation unit 33, is transmitted from the operating unit 33 to the command processing circuit 21. Superimposition data for superimposed display on the monitor TV receiver 35 are provided by a superimposition processing circuit 25 in response to the display signals from circuit 24 and are transmitted to the monitor TV receiver 35 for superimposition on picture signals from the VTR 10.

The VTR control circuit 23 is connected, through a bidirectional communication circuit 26, to the bidirectional control signal line BDL which is, in turn, connected to the bidirectional communication interfacing circuit 11 in the VTR 10. The operating state data from the operating state detection circuit 12 and data from the recording condition checking circuit 13 are transmitted to the interfacing circuit 11 and various data are exchanged between the interfacing circuit 11 and a system controller 14 of the VTR 10. The VTR system controller 14 transmits information, such as servo lock information, monitored RF levels and the like, to the detection circuit 12 which determines therefrom if a recording operation is in progress. The system controller 14 transmits information on the presence or absence of the RF signals or the video signal level to the checking circuit 13 during the reproduction of recorded test signals to determine if the recording of such test signals was properly performed.

Bidirectional communication between the bidirectional remote control unit 20 and each of the VTRs 10_1, 10_2, ... 10_n will now be described with reference to Figure 3. In Figure 3 a first modulating circuit 27a in the bidirectional remote control unit 20 receives control signals, for example, from the VTR control circuit 23 (Figure 2) and modulates them by a first modulation frequency, such as 800 kHz, before transmitting the modulated signal to a buffer amplifier 27c through a bandpass filter (BPF) 27b having the modulating frequency as its centre transmission frequency. Output signals from the buffer amplifier 27c are transmitted through a switch 27d and a resistor 27e to the bidirectional control signal line BDL. A junction point in the remote control unit 20 between the resistor 27e and a terminal connected to the control signal line BDL is grounded through a resistor 27f of, for example, 75Ω for impedance matching. In this manner, modulated control signals from the remote control unit 20 are transmitted with a modulation frequency of 800 kHz over the signal line BDL to the VTRs 10_1, 10_2 ... 10_n.

The VTRs 10_1, 10_2 ... 10_n are shown on Figure 3 to be of similar construction. For example, in the VTR 10_1, a switch 17a has one terminal connected to the bidirectional control signal line BDL and another terminal grounded through a resistance 17b of, for example, 75 Ω, for impedance matching, and a switch 17c. The control signals passing through the switch 17a are further transmitted through a buffer amplifier 17d to a band pass filter (BPF) 17e having the above mentioned first modulating frequency of 800 kHz as its centre transmission frequency, so that signals around the first modulating frequency are extracted and are transmitted to a demodulating circuit 17f. In the demodulating circuit 17f, signals modulated by the first modulating frequency are demodulated and transmitted through the interfacing circuit 11 to the VTR system controller 14 (Figure 2).

Impedance matching of the transmission line is achieved by closing (turning ON) the switch 17a of the VTR currently being connected to the control signal line BDL, while the switches 17a of the remaining VTRs are all turned OFF (remain open).

The system controller 14 provided in the VTR (Figure 2) controls the VTR operation when the transmitted control signal is addressed to all of the VTRs or at least to associated VTRs, and formulates response signals, such as, operating state detection signals from the operating state detection circuit 12, when a response is required. These response signals are transmitted to a modulating circuit 18a (Figure 3) for modulation with a second modulating frequency, such as 200 kHz, which is different from the first modulating frequency, before being transmitted to a buffer amplifier 18c through a BPF 18b having the second modulating frequency of 200kHz as its centre transmission frequency. Output signals from buffer amplifier 18c are transmitted through a resistor 18d to a switch 18e which may be turned ON and OFF in response to control signals applied to a control input terminal 18f. Response signals from the switch 18e are transmitted through the switch 17a to the bidirectional control signal line BDL. The frequency characteristics of the BPFs 17e in VTRs 10_1, 10_2, ... and of the BPF 27b in the remote control unit 20 are set so as to inhibit the passage therethrough of signals of the second modulating frequency, that is, 200 kHz.

The response signals, modulated with the second modulating frequency of 200 kHz, are transmitted through the control signal line BDL to the remote control unit 20 in which the signals pass through a buffer

amplifier 28a to a lowpass filter (LPF) 28b having its cut-off determined for transmitting signals around the second modulating frequency. With the second modulating frequency at, for example, 200 kHz, the LPF 28b has a cut-off frequency of the order of 400 kHz for inhibiting the passage therethrough of signals of the abovementioned first modulating frequency at about 800 kHz. The signals around the second modulating frequency, separated by the LPF 28b, are delivered to a demodulation circuit 28c for demodulation.

A particular example of a signal communication system that may be employed for transmission over the bidirectional control signal line BDL, is a start-stop synchronized all-duplex communication system with data units of 8 bits each, odd numbered parity check bits and a baud rate of 38400 bits per second bps. In the communication hardware between the remote control unit 20 and each of the VTRs 10_1 - 10_n, collision detection is not performed and the remote control unit 20 commands the communication. In other words, the remote control unit 20 designates ID numbers or the like identifying a selected one of the VTRs 10_1 - 10_n and subsequently transmits actual commands. The IDs for the VTRs 10_1 - 10_n are classified into individual identification IDs and group identification IDs and a status response to a command may only be transmitted from the respective VTR directly after the command has been sent with a respective individual identification ID. Since communication between the bidirectional remote control unit 20 and the VTRs 10_1 - 10_n is a one-to-multiplicity type communication, a handshaking system, for example one involving the transmission of a negative acknowledgement signal (NAK) in the event of communication errors, cannot be employed. For this reason, the same data are sent a number of times to diminish the probability of data loss due to communication errors.

Figure 4 shows a specific example of a communication format suitable for use for the commands to be transmitted from the bidirectional remote control unit 20 to the VTRs. In this format a command word comprises (in the following order): a 1-byte communication start signal 'STX', a 1-byte serial number 'SN' a 3-byte 'ID' indicating the identification (ID) of the VTR to which the command is addressed, a number 'DN' indicating the number of bytes of data to follow, a data part 'DATA', a check sum 'SUM' indicating the sum of the data in the data part and a communication end signal 'ETX'. The serial number SN is incremented by one for each new command. The receiving VTR checks this field to discem which command is being received. In the case of individual identification of the VTRs, of the three bytes of the ID field, the first byte denotes ten thousands and thousands by the upper and lower 4 bits thereof, respectively, the second byte denotes hundreds and tens by the upper and lower 4 bits thereof, respectively, and the third byte denotes units by the upper 4 bits thereof, with the lower 4 bits thereof being zero. In the case of identification of the VTRs by groups, the first, second and third bytes of the ID field indicate 255,0 and the group number, respectively.

For transmitting signals from the bidirectional remote control unit 20 to the interfacing circuit 11 of a VTR, the signals are modulated by amplitude shift keying (ASK) in which logical ones and zeros of the 38.4 kbps baud rate data are associated with an 800 kHz burst signal and a zero amplitude state respectively. For transmitting signals from the interfacing circuit 11 of one of the VTRs to the bidirectional remote control unit 20, the signals are modulated in such a manner that logical ones and zeros are associated with a 200 Khz burst signal and a zero amplitude state respectively.

After a power source (not shown) of the remote control unit 20 is turned ON, self diagnoses and initialization of the unit are first performed, after which the VTRs connected to the remote control unit are checked to see if any one of the connected VTRs corresponds to the VTR individual ID number of a command or is included in the range of identification numbers represented by the group ID number included in the command.

For each of the VTRs, starting from the smallest ID number to the largest ID number, a VTR-ID designation command is transmitted, an acknowledging response (ACK) is received and the VTRs that are connected to the remote control unit are determined and registered. The connection confirmation time for each VTR is not more than 30 msec, for example, which is multiplied by the number of the designated VTRs to give a total connection confirmation time. For checking the state of the connection, a suitable connection is confirmed when a response ACK is transmitted back to the unit 20 within 10msec after the command transmission. If there is no response ACK within 10msec, or if a negative acknowledging response (NAK) is transmitted, the operation is repeated once again, and, if no response ACK is received, non-connection is confirmed.

After initialization of the bidirectional remote control unit 20, confirmation of its connection with the operating unit 33 and title display, the basic state for usual operation is set. Starting from this basic state, a state for registration of the usual operations, a state for setting of the VTR modes, time setting states, a state for self-analyses of the VTRs, a state for setting of the VTR modes, a state for the display of the VTR status, a state for setting of the user IDs or a state for setting of the VTR-IDs can be set in response to actuation of corresponding command keys of the operating unit 33. Any such operating state proceeds to an error state in the event that an error occurs at the time of key entry. Although key entry is described as being effected at the operating unit 33, it is also possible to effect key entry by the key entry unit 32K of the in-

put/output terminal device 32. Although display of the various operating states is performed by superimposition on a screen of the monitor TV screen 35, such display may also be made on the display section of the operating unit 33 or the CTR monitor 32C, or by printing by the printer 34.

In the above mentioned basic state, control of the VTRs under control, display of the operating states of the signal-selecting VTR, VTR-ID incrementing and decrementing and shifting to the above described states, are effected. The phrase "VTRs under control" means the VTRs within the VTR-ID range and thus the VTRs in the group confirmed to be connected (in the case of the group identification) or the individual VTR which has been identified (in the case of individual identification) whether or not actual connection of that individual VTR has been confirmed. The phrase "signal-selecting VTRs" means those VTRs which are within the VTR-ID range and the video, audio and RF signals of which are selected. The operating states of these signal-selecting VTRs and the states of the VTRs under control are monitored and the displays thereof are suitable modified. The VTR-ID display is changed by VTR-ID incrementing or decrementing. A VTR control operating key can be used in this basic state for operating the VTR.

By pressing a status key, for example, the operating state may be changed from the basic state to the VTR status display state. In the VTR status display state, the VTR setting state, the VTR error state and time meter are displayed. Corresponding data may be printed out by the printer 34 at this time. In the VTR error status display, the number of the VTRs in an error state, the VTR-IDs of the VTRs in the error state and the error codes and the like are displayed.

The bidirectional remote control unit 20 effects confirmation of connection, operating states and error states of the VTRs 10_1 - 10_n. The VTRs under control, and mainly the signal-selecting VTRs, are monitored. In other words, the operating states of the signal-selecting VTRs, the error states of the signal-selecting VTRs and the error states of the VTRs other than the signal-selecting VTRs are confirmed repeatedly. The VTRs other than the signal-selecting VTRs are confirmed by sequentially scanning from the smallest ID to the largest ID in the VTR-ID range.

Referring now to Figure 5, it will be assumed that a signal packet ST_1 indicates signals of the format shown in Figure 4, transmitted from the bidirectional remote control unit 20 over the bidirectional control signal line BDL, and that the VTR-ID in the packet ST_1 identifies the first VTR 10_1. In response to the transmitted packet ST_1, a responsive signal packet SR_1 is sent from the VTR 10_1 over the bidirectional control signal line BDL. The time allocated to this one monitoring operation (Ta), that is, the time from the start of transmission of the packet ST_1 until transmission of a packet ST_2 designating the next VTR 10_2, is, for example, 80 msec. Thus, in the example give, a time of 1000 x Ta, or 80 sec is required for scaming the 1000 VTRs connected to the control unit 20. If the first VTR 10_1 is a signal-selecting VTR, this signal selecting VTR 10_1 is monitored once for each predetermined number, such as, ten, of the monitoring operations. In such case, the monitoring period Tb for this signal-selecting VTR is 10 x Ta or 800 msec. It will be noted that, if the signal-selecting VTR was monitored only as part of the scan of the VTRs in their entirety, the operating states or the error states of the individual signal selecting VTRs would be updated only once in 80 sec, for the example given, so that the image displayed on the monitor screen would not accurately reflect the actual monitored operating states.

The operating states of the VTRs are detected by the respective operating state detection circuits 12. The states to be checked by each operating state detecting circuit 12 when monitoring the error states include tape unthread, various tape troubles, head errors, servo alarm and system alarm. The states to be checked by the circuit 12 may also include such items as record mode flag, servo lock, tape end, failure of video signals and failure of synchronization signals, if the operating mode of the respective VTR is the recording mode. In this manner, recording commands are transmitted to, for example, all of the VTRs 10_1 - 10_n and, while the video or audio signals from the master VTR are being recorded or dubbed, the operating states of the VTRs are detected, that is, it is detected if these VTRs are in the normal recording mode. The number of the VTRs in error, that is, not in the normal recording mode, and the IDs and the error status of the VTRs in error are displayed or printed.

The operation of automatically checking the results of recording by the VTRs 10_1 - 10_n, that is the operation of automatically recording test signals and inspecting the results of the recording, will now be explained with reference to Figure 6. In Figure 6, P_1 represents a dubbing start point on a video tape in a selected one of the VTRs 10_1 - 10_n, and a video program to be duplicated is recorded or dubbed on the tape for an interval a from the start point P_1 to a point P_2. On completion of such dubbing, the host CPU 31 (Figure 1) controls the bidirectional remote control unit 20 to cause the selected VTR to change-over to its fast-forward mode, whereby the tape is made to run at a high speed from the dubbing end point P_2 to a predetermined test signal recording start point P_3. The test signals are intended to be supplied from the test signal generator 3 to the VTRs through the change-over switch 2, and the test signal generator 3 and the changeover switch 2 are controlled by the host CPU 31 so as to cause test signals to be recorded from the point P_3 for an interval b, for example, of 10 seconds, up to the point P_4. At the point P_4, the host CPU 31 causes the VTR to change-over to its rewind mode so as to effect high-speed rewind of the tape to a prede-

termined extent, as at c on Figure 6. Then, the host CPU 31 causes the VTR to enter its reproducing or playback mode, at d on Figure 6, for reproducing the recorded test signals. During playback, the reproduced test signals are checked by the recording result checking circuit 13 associated with the VTR, as shown in Figures 1 and 2.

Among the items that are checked during reproduction of the recorded test signals, are the presence or absence of RF signals, whether or not the video-/sync signals have been detected, whether or not tracking is normal, and the presence or absence of audio signals. If unsatisfactory results are obtained after sequentially checking these items, the power source of the VTR undergoing the test is turned off and an alarm is actuated, for example, by turning alarm lamps on and off. Further, the VTRs are sequentially designated and monitored by the remote control unit 20 for displaying or printing the number and/or the IDs of the VTRs in which unsatisfactory recording of the test signals is detected.

After completion of the playback of the recorded test signal at d in Figure 6, the tape is rewound, as at e, and then erased as at f, from a position slightly ahead of the point P_3. The tape is erased to a point P_5 which is beyond the point P_4 and at which the test is completed. In any case where playback of the recorded test signal indicates that the recording operation of the VTR in question has proceeded normally and without defect or error, from point P_5, the recorded tape is fully rewound, as at g on Figure 6, and, at the conclusion of such rewinding operation, the recorded or duplicate tape is withdrawn from the respective VTR. By fully rewinding only those tapes indicated to be recorded properly, recorded tape cassettes suitable to be marketed can be readily distinguished from tape cassettes likely to contain recording defects.

Any VTRs found, during playback of the recorded test signal at d, to be recorded defectively or otherwise experiencing trouble, are automatically turned off, and the recorded tapes are not extracted from such VTRs. Thus, the inconvenience and wasted effort of removing tapes from VTRS that are not operating properly during the recording operation may be effectively avoided.

In the tape duplicating apparatus described above with reference to Figure 1, only a single master VTR 1 is provided for reproducing the master tape which is to be duplicated in all of the recording units or VTRs 10_1 - 10_n under the control of the single bidirectional remote control unit 20. Furthermore, in the apparatus described with reference to Figure 1, the total number of the VTRs 10_1 - 10_n is effectively limited to 1000.

However, as shown on Figures 7 and 8, a tape duplicating apparatus according to another embodiment of this invention employs a plurality of master VTRs, as at 1_1 - 1_8 and may be capable of duplicating or dubbing tapes in up to 2000 VTRs 10_{1A} -$10_{1,000A}$ and 10_{1B} - 10_{1000B}. Figure 7 particularly shows a system in the tape duplicating apparatus for controlling the operations of the master VTRs 1_1-1_8 and the recording units or VTRs in which the tapes are duplicated, while Figure 8 particularly illustrates a system by which video and audio signals being reproduced in the master VTRs are selectively supplied to the various recording units or VTRs in which the duplicate tapes are to be recorded.

More specifically, in Figure 7, two bidirectional remote control units 20A and 20B are connected through a system control unit 30 to the host computer 31 for performing bidirectional remote control operations of duplicating VTRs arranged in two channels, respectively. More specifically, the bidirectional remote control units 20A and 20B are connected through bidirectional control signal lines BDLA and BDLB, respectively, to VTRs 10_{1A}, 10_{1000A} and to VTRs 10_{1B}-10_{1000B}. The host computer 31 also controls, through the system control unit 30 and a master VTR remote control unit 4, the operations of the 8 master VTRs 1_1 -1_8, and also the operation of the test signal generator 3.

As shown on Figure 8, serially transmitted digital video and audio signals from the master VTRs 1_1 -1_8 and from the test signal generator 3 are selectively delivered through a digital switcher 6 to signal separators or decombiners 8_1 -8_{10} provided on several racks mounting respective groups 40-49 of the duplicating VTRs. The digital switcher 6 is connected to the system control unit 30 through an interfacing circuit 7 (Figure 7). Each of the signal separators or decombiners 8_1 -8_{10} includes a digital-to-analogue converter and separates the serially transmitted digital video and audio signals obtained from the digital switcher 6 into separated analogue video signals V and two-channel audio signals A_1 and A_2 which are transmitted through distributors 9_1, 9_2, 9_3 ... to respective duplicating VTRs 10_{1A}-10_{10A}, 10_{11A}-10_{20A}, 10_{21A}-10_{30A}, ... Since each of the signal separators 8_1-8_{10} is associated with a group 40-49 of the duplicating VTRs, for example, 100 of such VTRs, mounted on a respective rack with the respective signal separator or digital-to-analogue converter, signals from different master VTRs may be simultaneously recorded on tapes in selected ones of the groups 40-49 of duplicating VTRs on different racks. Thus, if eight different master tapes are simultaneously played back by the master VTRs 1_1 -1_8, respectively, those eight master tapes can be duplicated simultaneously in eight different groups of the duplicating VTRs.

It will be appreciated that the embodiment described above with reference to Figures 7 and 8 is arranged and operates similarly to the embodiment described above with reference to Figure 1 except to the extent specifically mentioned above in consequence of its employing a plurality of master VTRs and an in-

creased number of duplicating VTRs arranged in two-channels, respectively, and communicating with respective bidirectional remote control units 20A and 20B through bidirectional control signal lines BDLA and BDLB, respectively.

Figure 9 illustrates the physical construction of one embodiment of the tape duplicating apparatus. The apparatus comprises a rack 50 forming a remote control console, a rack 60 for the master VTRs, and one or more racks 70 for respective groups of the duplicating VTRs.

The rack 50 forming the remote control console has mounted thereon the host CPU 31, keyboard 32K, CRT monitor 32C, printer 34, monitor TV receivers 35, waveform monitor 36, audio amplifier 37 and oscilloscope 38, all corresponding to the similarly identified elements in Figure 1. The bidirectional remote control unit 20 and the operating unit 33 on Figure 1 are contained in a single unit 51 on Figure 9. Further, a power source 52 is provided in the rack 50 of the remote control console.

The master VTR rack 60 is provided with a monitor TV receiver 61, a vector scope 62, a waveform monitor 63, an audio amplifier 64, two digital VTRs 1_1 and 1_2 corresponding to the master VTR 1 on Figure 1, and a power source 65.

Each of the plurality of racks 70 for the duplicating VTRs has mounted thereon a number of recording units or VTRs indicated as 80 on Figure 9 and which correspond to the VTRs 10_1 - 10_n of Figure 1, a monitor TV receiver 71 and a level meter 72, as may be required.

Each of the VTRs 80 for tape duplication or dubbing is employed in conjunction with a respective automatic tape changer 90, for example as shown in Figure 10. Each VTR 80 is shown to have, at its front panel, a cassette inserting opening 81, a power source switch 82, an eject button 83 and operating mode selecting buttons 84.

The automatic tape changer 90 for automatically inserting a video tape cassette 85 into the associated VTR 80 is mounted in front of the VTR. The automatic tape changer 90 is shown to have an upper cassette holder 91 capable of holding a plurality, for example, four, video tape cassettes 85, and a lower cassette holder 94 capable of holding up to two cassettes 85 after the latter have been extracted or ejected from the associated VTR 80. At the front of the automatic tape changer 90, there are provided an upper empty indicator 92, a lower full indicator 93, a reset button 95, an eject button 96, a start button 97, a tape running indicator 98 and an automatic VTR OFF and error eject indicator 99. The upper empty indicator 92 is turned ON when there is no tape cassette 85 in the upper cassette holder 92. Further, the indicator 92 is intermittently turned ON when a tape cassette 85 in the upper holder 92 is incorrectly oriented. The lower full indicator 93 is maintained in its OFF condition when there is not tape cassette 85 in the lower cassette holder 94 or when the latter contains only one tape cassette 85. The indicator 93 is turned ON continuously when the lower cassette holder is full, that is, when there are two cassettes 85 therein, and the indicator 93 is intermittently turned ON when the VTR seeks to eject a cassette even though the lower cassette holder 94 contains its full complement of two tape cassettes 85. The indicators 92 and 93, when intermittently turned ON as described above, are desirably ON and OFF for equal intervals of, for example, 1 second. The automatic OFF and error eject indicator 99 is turned ON continuously when no tape cassette 85 is loaded in the respective VTR 80, or at the time of the ejection of a cassette from the VTR. Further, the indicator 99 is intermittently turned ON, at an interval of, for example, 0.1 second, when the respective VTR 80 has been automatically changed-over to its OFF mode, for example, in response to an indication that the VTR is not performing its recording operation in a normal manner. Alternatively, the indicator 99 is intermittently turned ON at an interval of, for example, 1 second, when an error or malfunction occurs during the changer operation. When an error or cause of such malfunction has been cleared, the system can be reset by actuating the reset button 95, thereby to halt the intermittent energizing of the indicator 99 at the 1 second interval.

It will be appreciated that in the embodiments described above the control or command signals transmitted from the remote control unit 20 to the plurality of tape recording units or VTRs 10_1 - 10_n and the response signals from the VTRs 10_1 - 10_n are frequency and time-division multiplexed so that signal collisions may be avoided while transmitting the control and response signals over a single bidirectional control signal line, with the result that the connections between the various components of the apparatus can be substantially simplified.

Further, the recording operation of each of the duplicating VTRs is checked automatically by the test procedure described above with reference to Figure 6, and, in the event that such test procedure indicates improper recording of the test signals, the respective duplicating VTRs is automatically turned off, thereby to ensure that the respective duplicating tape will not be marketed.

Claims

1. Tape duplicating apparatus comprising:
   at least one source (1) of video and audio signals (V, A_1, A_2);
   a plurality of tape recording units (10);
   means (2, 5) for connecting said tape recording units (10) with said source (1) so that said tape recording units (10) can simultaneously re-

cord said video and audio signals (V, A_1, A_2).

a bidirectional control signal line (BDL) connected to all of said tape recording units (10);

remote control means (20) including means (33, 21, 22, 23) for generating command signals for said tape recording units, and first modulating means (27a) for modulating said command signals with a first modulating frequency to provide modulated command signals supplied through said bidirectional control signal line (BDL) to said tape recording units (10);

each of said tape recording units (10) including means (17f) for demodulating the modulated command signals, means (12, 13) for generating response signals in response to at least a subset of the demodulated command signals, and second modulating means (18a) for modulating said response signals with a second modulating frequency different from said first modulating frequency to provide modulated response signals supplied through said bidirectional control signal line (BDL) to said remote control means (20).

2. Tape duplicating apparatus according to claim 1, further comprising means for time division multiplexing said modulated response signals and said modulated command signals as supplied through said bidirectional control signal line.

3. Tape duplicating apparatus according to claim 1 or claim 2 in which said at least one source (1) of video and audio signals (V, A_1, A_2) comprises at least one master video tape reproducing device (1).

4. Tape duplicating apparatus according to any one of the preceding claims, further comprising means (12) associated with each of said tape recording units for detecting an operating state thereof in response to a respective command signal from said remote control means (20), and for generating an operating state indicating signal as the respective response signal supplied to said remote control means.

5. Tape duplicating apparatus according to claim 4, further comprising monitor means (35), means (24) for displaying on said monitor means video signals recorded by a selected one of said tape recording units; and means (25) for superimposing, on the displayed video signals, a display corresponding to said operating state indicating signal.

6. A tape duplicating apparatus comprising:

at least one source (1) of video and audio signals (V, A_1, A_2);

a plurality of tape duplicating units (10) having recording and playback modes;

means (25) for connecting said tape duplicating units (10) with said source (1) in said recording mode of the tape duplicating units (10) so that said tape duplicating units (10) simultaneously record said video and audio signals (V, A_1, A_2)

test signal generating means (3) for providing a test signal;

means (2, 5) for applying said test signal to said tape duplicating units (10) in said recording mode of the tape duplicating units (10) for recording said test signal;

means (31, 20) for changing said tape duplicating units (10) to said playback mode so as to reproduce the recorded test signal; and

detecting means (13) associated with each of said tape duplicating units (10) for indicating a defect in the recording operation of the respective tape duplicating unit (10) in response to the test signal reproduced therefrom.

7. A tape duplicating apparatus according to claim 6, comprising control means (31, 20) responsive to said detecting means (13) for rendering inoperative said respective tape duplicating unit (10) when a defect in the recording operation of that tape duplicating unit (10) is indicated.

8. A tape duplicating apparatus according to claim 7, in which said control means (31, 20) causes said respective tape duplicating unit (10) to erase said recorded test signal and then to fully rewind the respective tape when said detecting means fails to detect therefrom a defect in the recording operation of the tape duplicating unit (10).

9. A tape duplicating apparatus according to claim 7; in which said control means causes said respective tape duplicating unit (10) to erase said recorded test signal when said detecting means (13) detects therein no defect in the recording operation of the tape duplicating unit (10).

10. A tape duplicating apparatus according to any one of claims 6 to 9 in which said tape duplicating units (10) are selected one-at-a-time in a predetermined sequence, for detecting defects in the recording operation of the respective tape duplicating unit (10).

11. A method of duplicating a master tape recorded with video and audio signals (V, A_1, A_2), the method comprising the steps of;

playing back said master tape so as to obtain said video and audio signals (V, A_1, A_2) reproduced therefrom;

applying the reproduced video and audio

signals (V, A_1, A_2) to a plurality of duplicating video tape recorders (10) for simultaneous recording on respective tapes;

selectively applying a test signal to said duplicating video tape recorders (10) for recording on the respective tapes;

reproducing the recorded test signal; and

detecting from the reproduced test signal whether there is a defect in the recording operation of the respective duplicating video tape recorder (10).

12. A method according to claim 11 further comprising the step of rendering inoperative any of the duplicating video tape recorders (10) found to have a defect in the recording operation.

13. A method according to claim 11 or claim 12, further comprising the step of erasing the recorded test signal in each instance where a defect in the recording operation of the respective duplicating video tape recorder (10) is not detected.

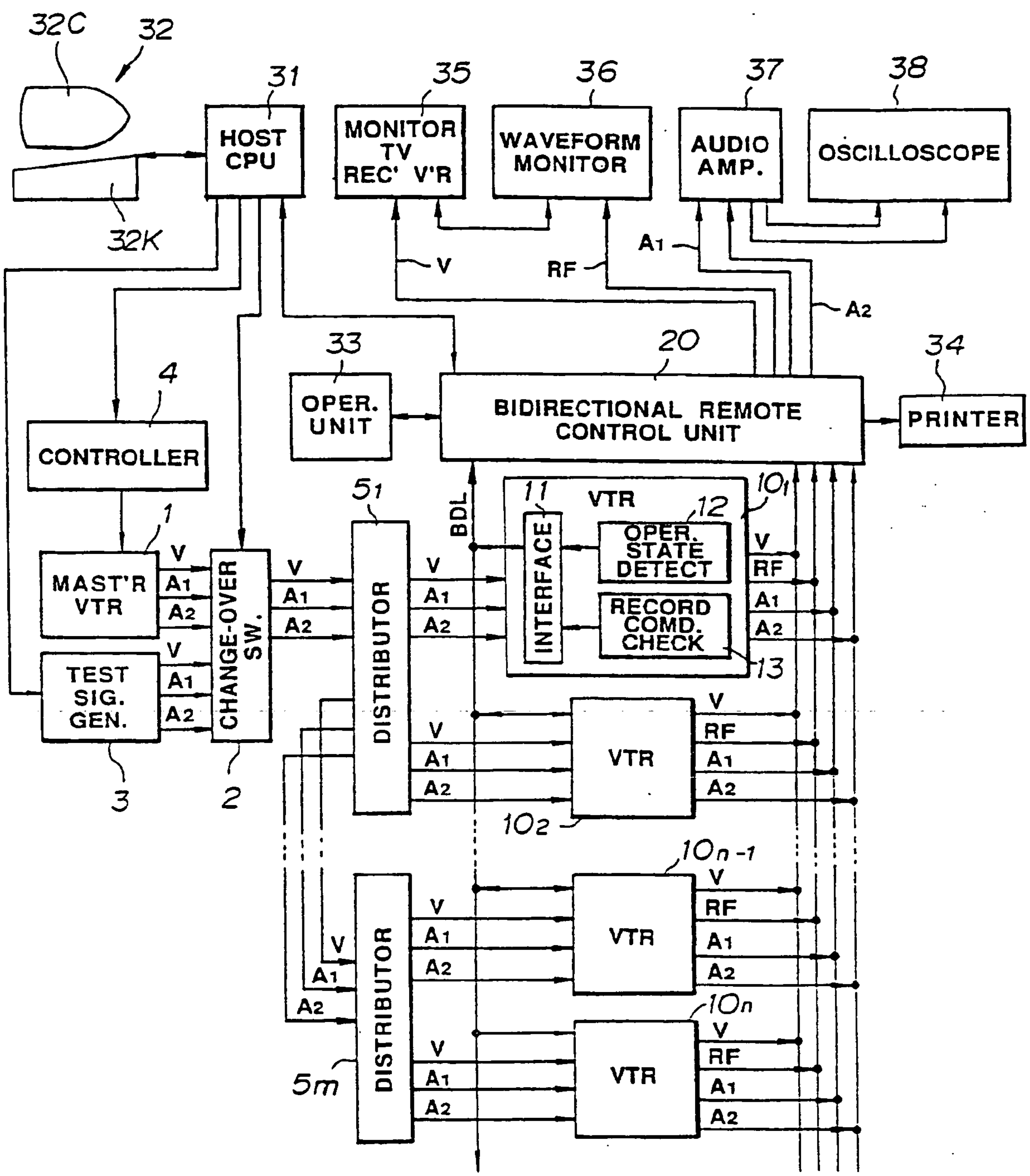
32C
32
31
HOST CPU
35
MONITOR TV REC' V'R
36
WAVEFORM MONITOR
37
AUDIO AMP.
38
OSCILLOSCOPE
32K
V
RF
A1
A2
33
OPER. UNIT
20
BIDIRECTIONAL REMOTE CONTROL UNIT
34
PRINTER
4
CONTROLLER
51
BDL
11
VTR
12
101
INTERFACE
OPER. STATE DETECT
RECORD COMD. CHECK
13
1
MAST'R VTR
TEST SIG. GEN.
CHANGE-OVER SW.
DISTRIBUTOR
3
2
VTR
102
10n -1
10n
5m

FIG.1

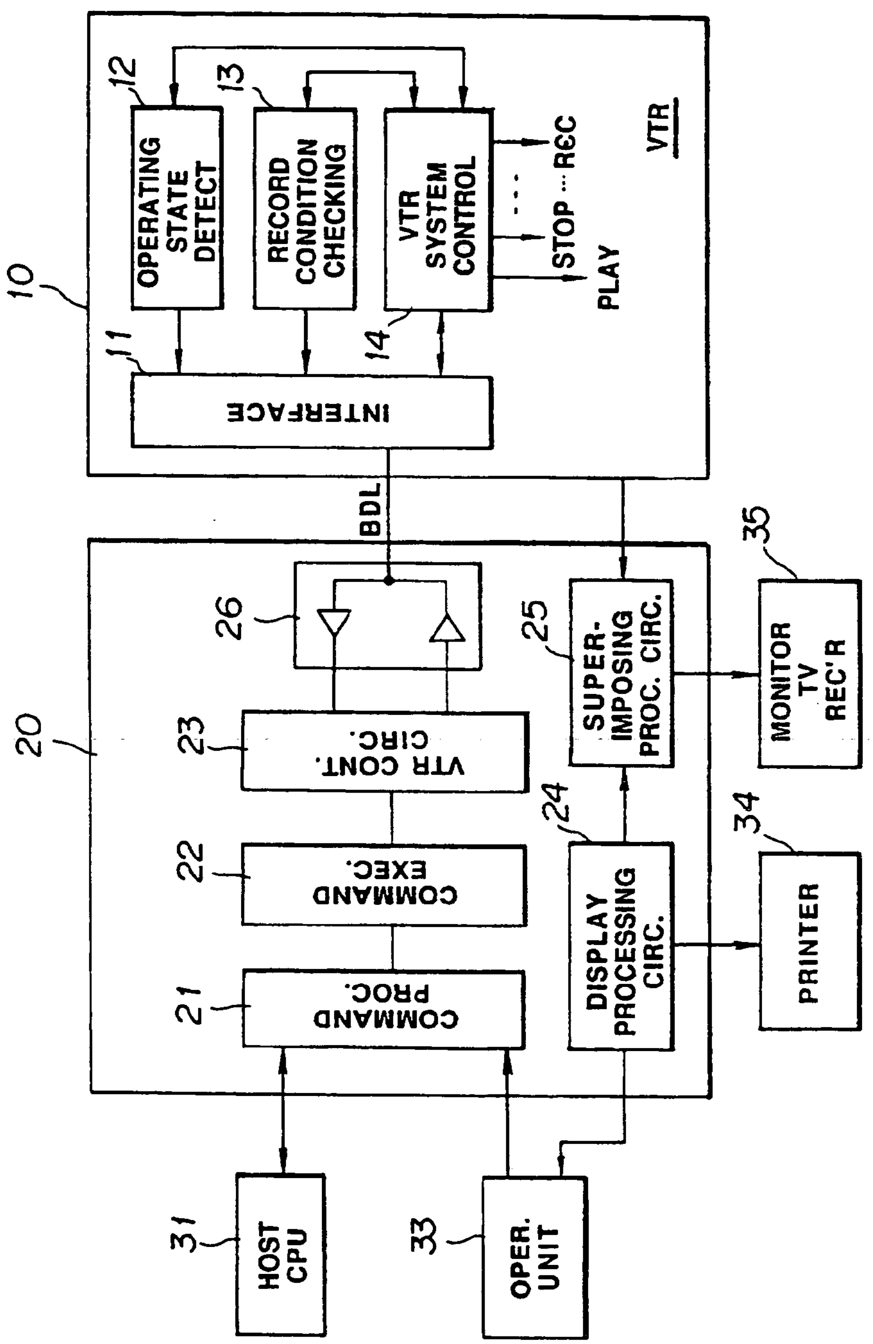
VTR
10
OPERATING STATE DETECT
12
RECORD CONDITION CHECKING
13
VTR SYSTEM CONTROL
14
PLAY
STOP
REC
INTERFACE
11
BDL
20
26
VTR CONT. CIRC.
23
COMMAND EXEC.
22
COMMAND PROC.
21
SUPER-IMPOSING PROC. CIRC.
25
DISPLAY PROCESSING CIRC.
24
MONITOR TV REC'R
35
PRINTER
34
HOST CPU
31
OPER. UNIT
33

FIG.2

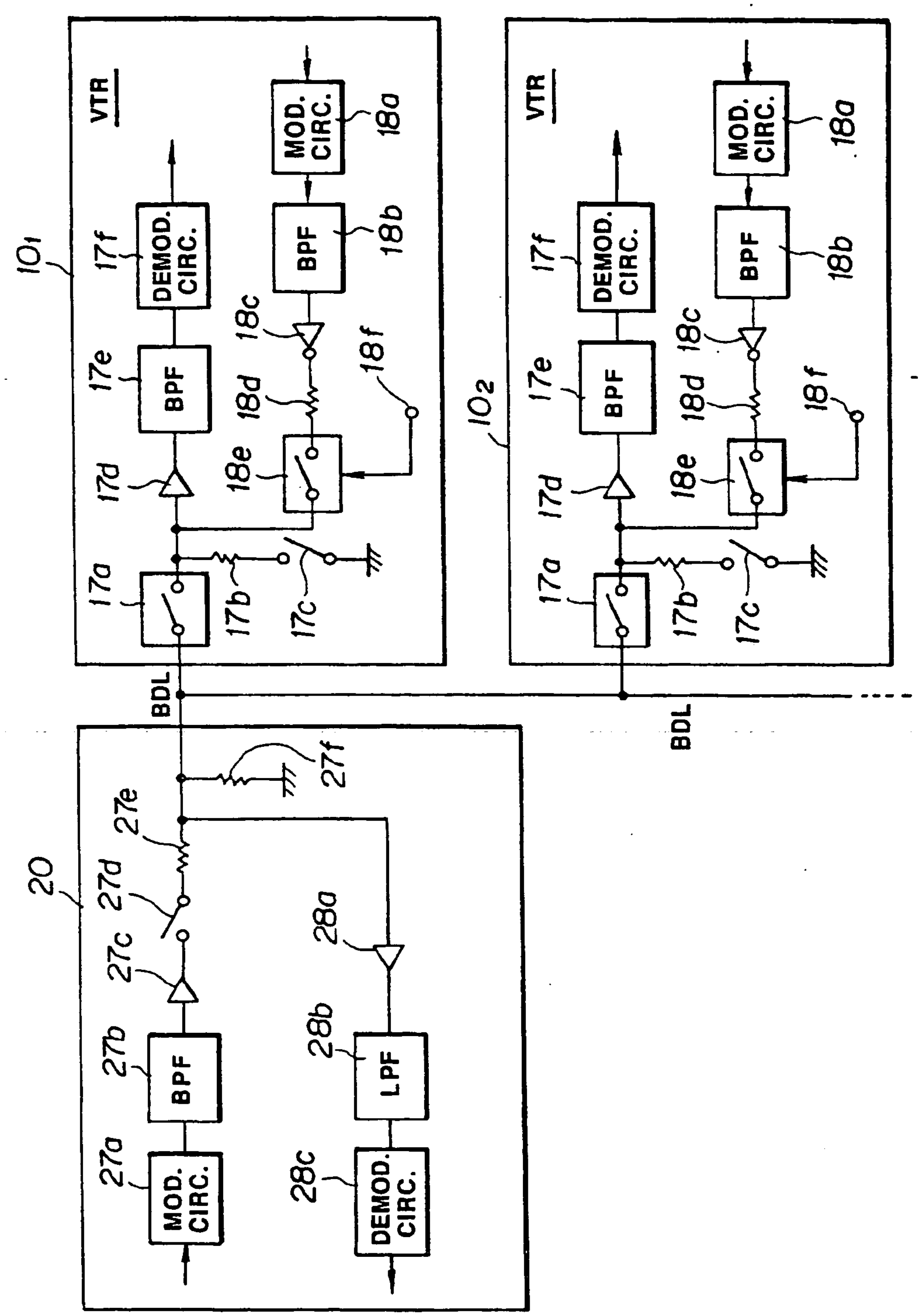
VTR
MOD. CIRC.
DEMOD. CIRC.
BPF
LPF
BDL
10₁
10₂
20
17a
17b
17c
17d
17e
17f
18a
18b
18c
18d
18e
18f
27a
27b
27c
27d
27e
27f
28a
28b
28c

FIG. 3

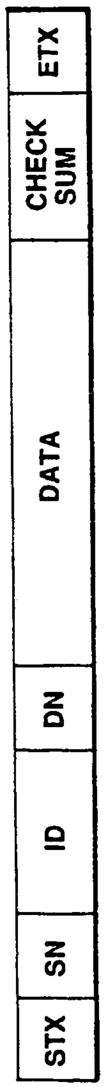
STX
SN
ID
DN
DATA
CHECK SUM
ETX

FIG. 4

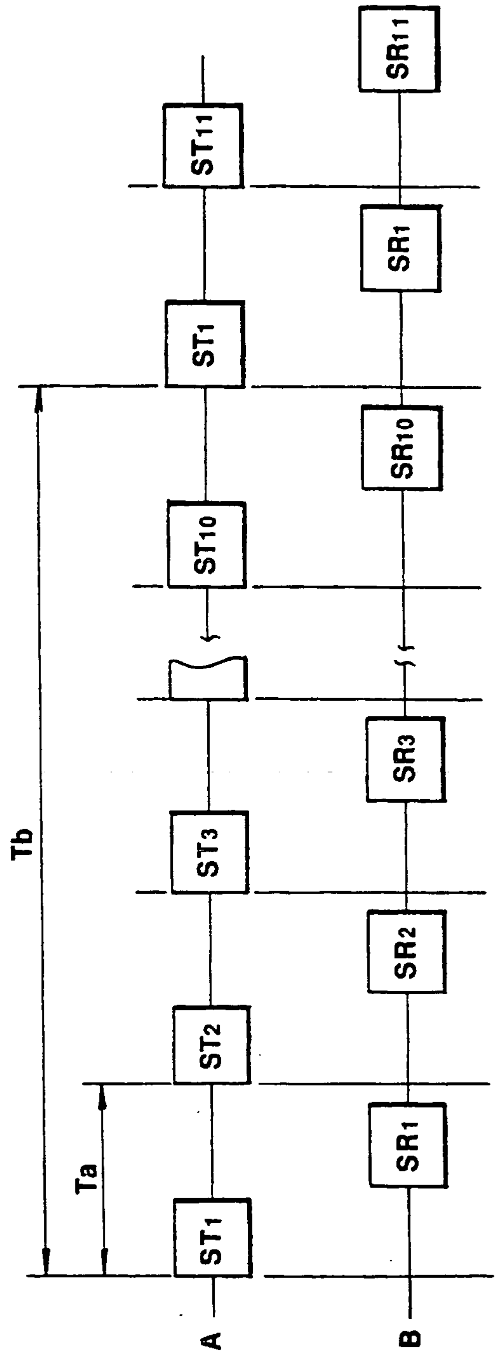
A
B
Ta
Tb
ST_1
ST_2
ST_3
ST_{10}
ST_1
ST_{11}
SR_1
SR_2
SR_3
SR_{10}
SR_1
SR_{11}

FIG. 5

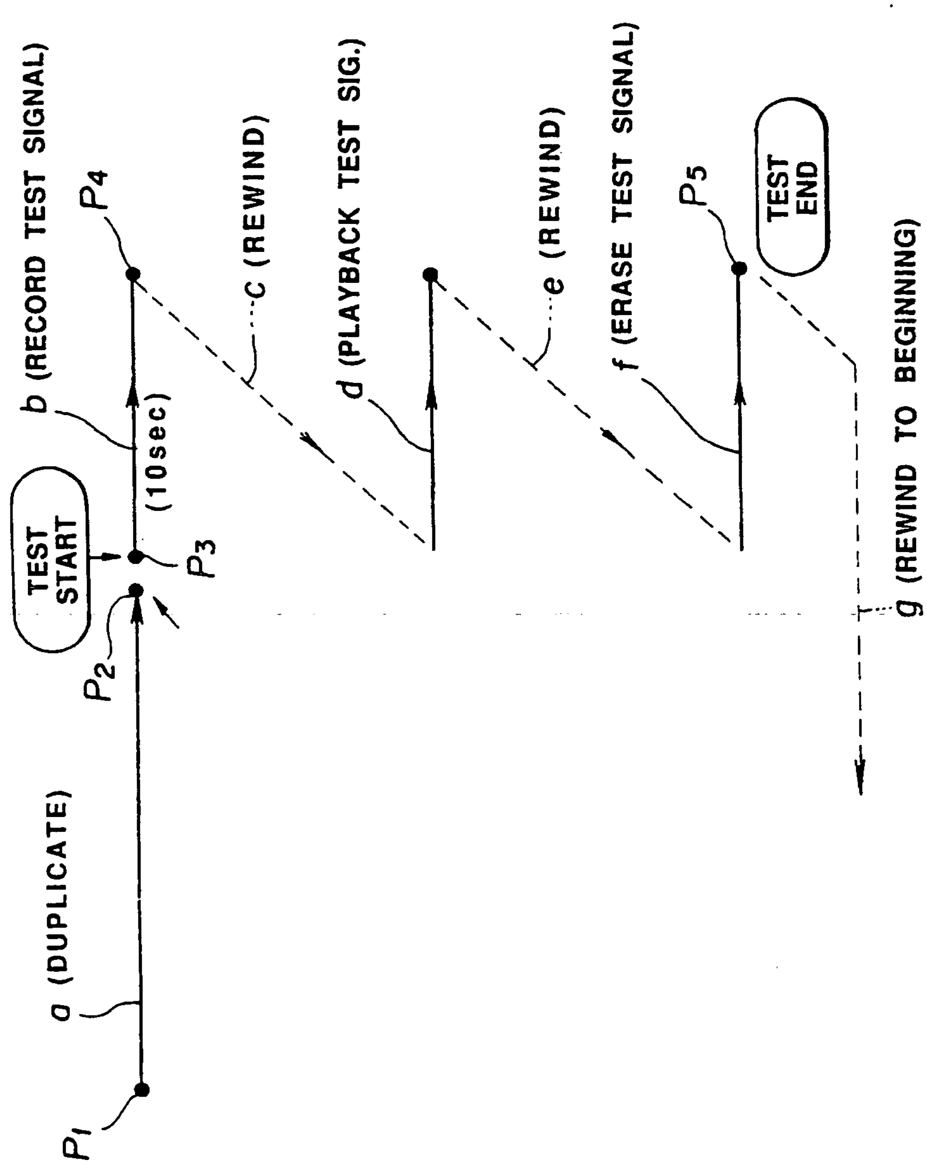
P1
a (DUPLICATE)
P2
TEST START
P3
(10sec)
b (RECORD TEST SIGNAL)
P4
c (REWIND)
d (PLAYBACK TEST SIG.)
e (REWIND)
f (ERASE TEST SIGNAL)
P5
TEST END
g (REWIND TO BEGINNING)

FIG.6

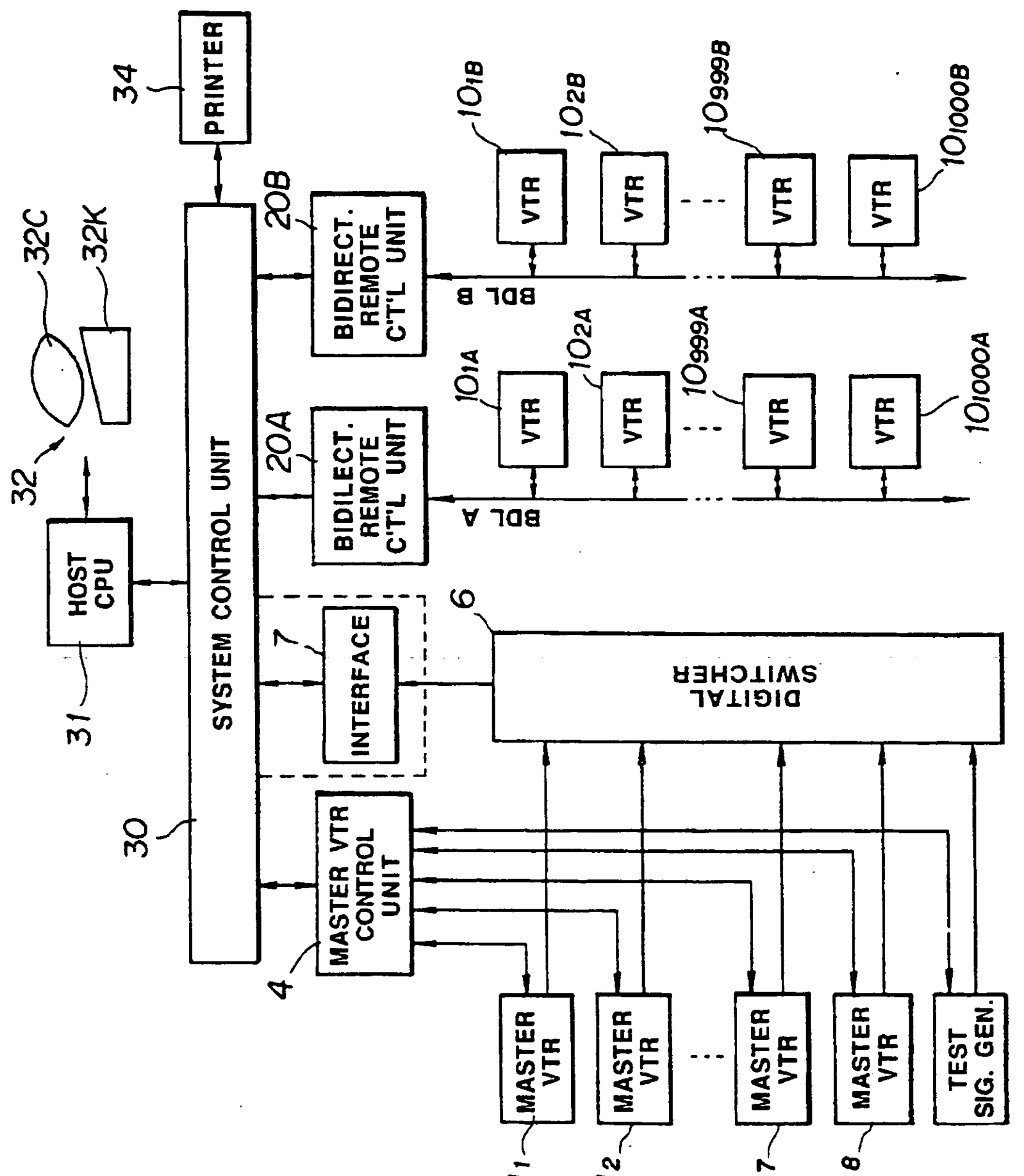
PRINTER
HOST CPU
SYSTEM CONTROL UNIT
BIDIRECT. REMOTE C'T'L UNIT
BIDILECT. REMOTE C'T'L UNIT
INTERFACE
DIGITAL SWITCHER
MASTER VTR CONTROL UNIT
VTR
BDL A
BDL B
MASTER VTR
TEST SIG. GEN.
34
32C
32K
32
31
30
20A
20B
7
6
4

FIG. 7

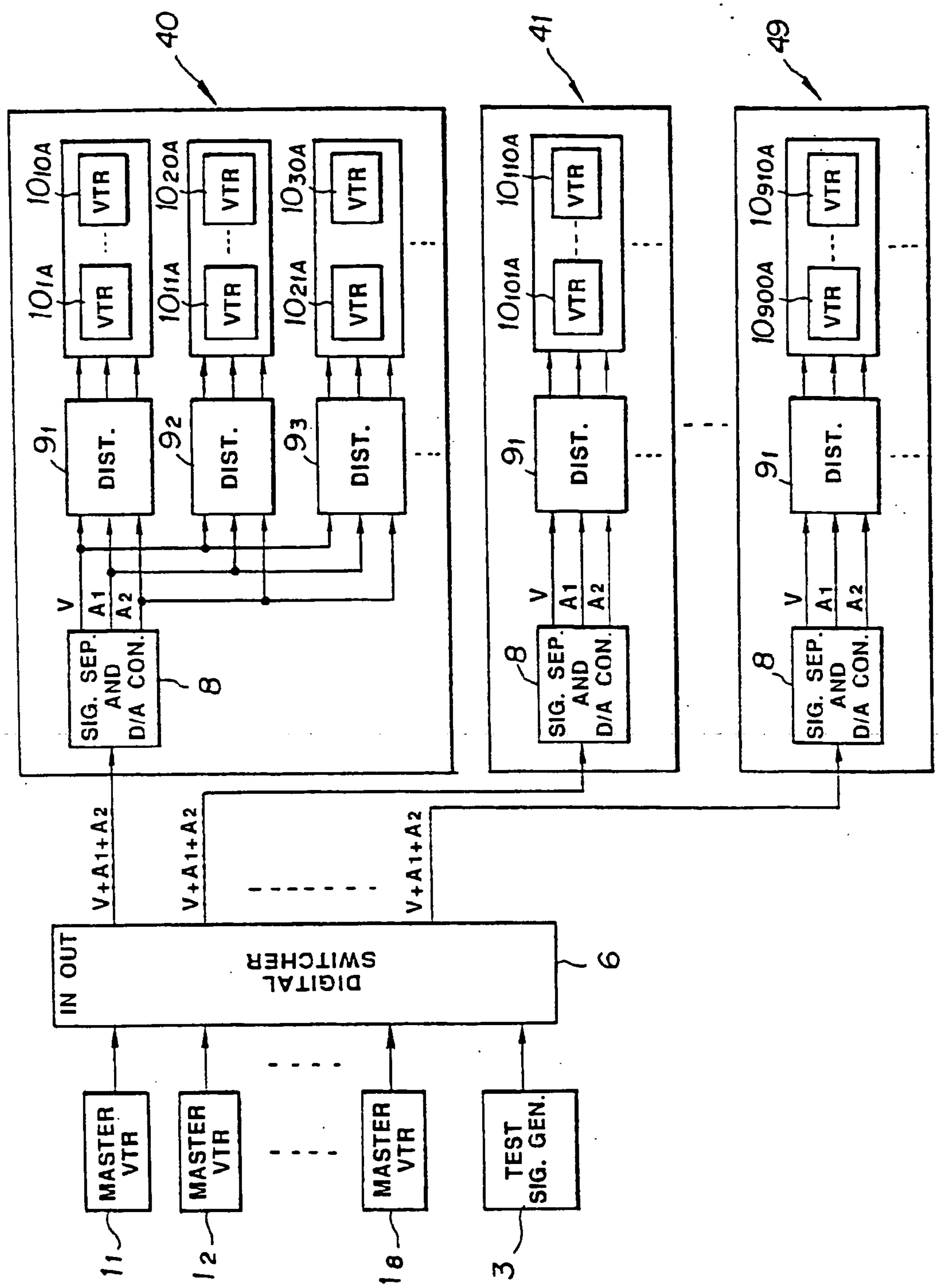
MASTER VTR
MASTER VTR
MASTER VTR
TEST SIG. GEN.
DIGITAL SWITCHER
IN OUT
V+A1+A2
V+A1+A2
V+A1+A2
SIG. SEP. AND D/A CON.
V
A1
A2
DIST.
VTR
40
41
49
6
3
8

FIG.8

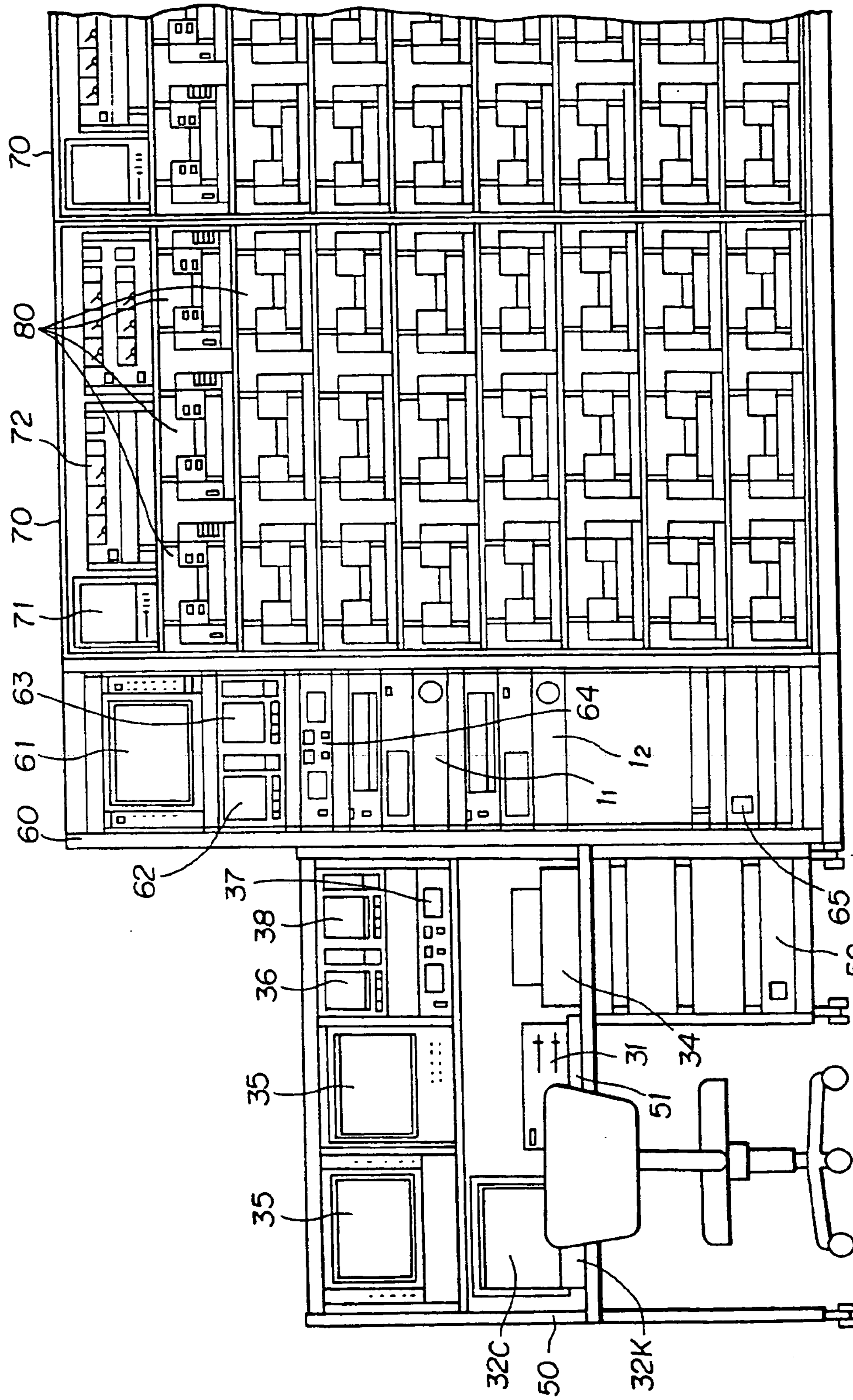
70
80
72
70
71
63
61
60
62
64
12
11
37
38
36
35
35
65
52
34
31
51
32C
50
32K

FIG. 9

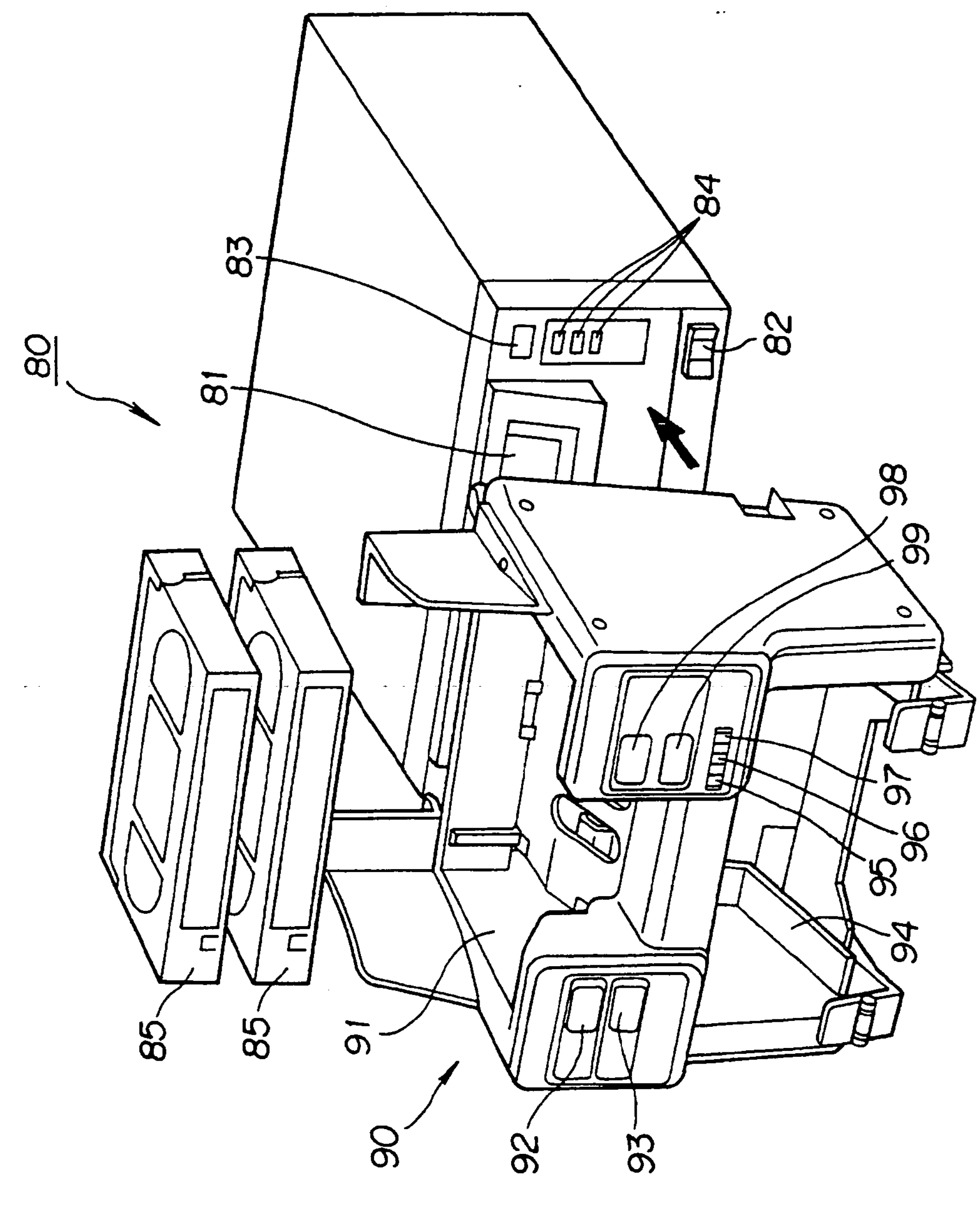

FIG.10